Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

For more information :

+65 6760 6647

www.tigernix.com

21 Woodlands Cl, #05-47 Primz Bizhub, Singapore 737854

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Introduction

Water reticulation networks constitute one of the most valuable and critical infrastructure assets owned by utilities. Many systems were installed several decades ago and are approaching or exceeding their design life. As assets deteriorate, the frequency of failures increases, resulting in water losses, service disruptions, repair costs, and customer dissatisfaction.

Historically, utilities relied on age-based replacement strategies. While age remains an important indicator of deterioration, modern asset management practices recognise that failure risk is influenced by multiple factors, including material type, soil conditions, pressure fluctuations, environmental factors, maintenance history, and operational stresses.

Risk-Cost-Performance Analysis addresses these limitations by evaluating assets based on actual risk exposure and performance outcomes rather than age alone.

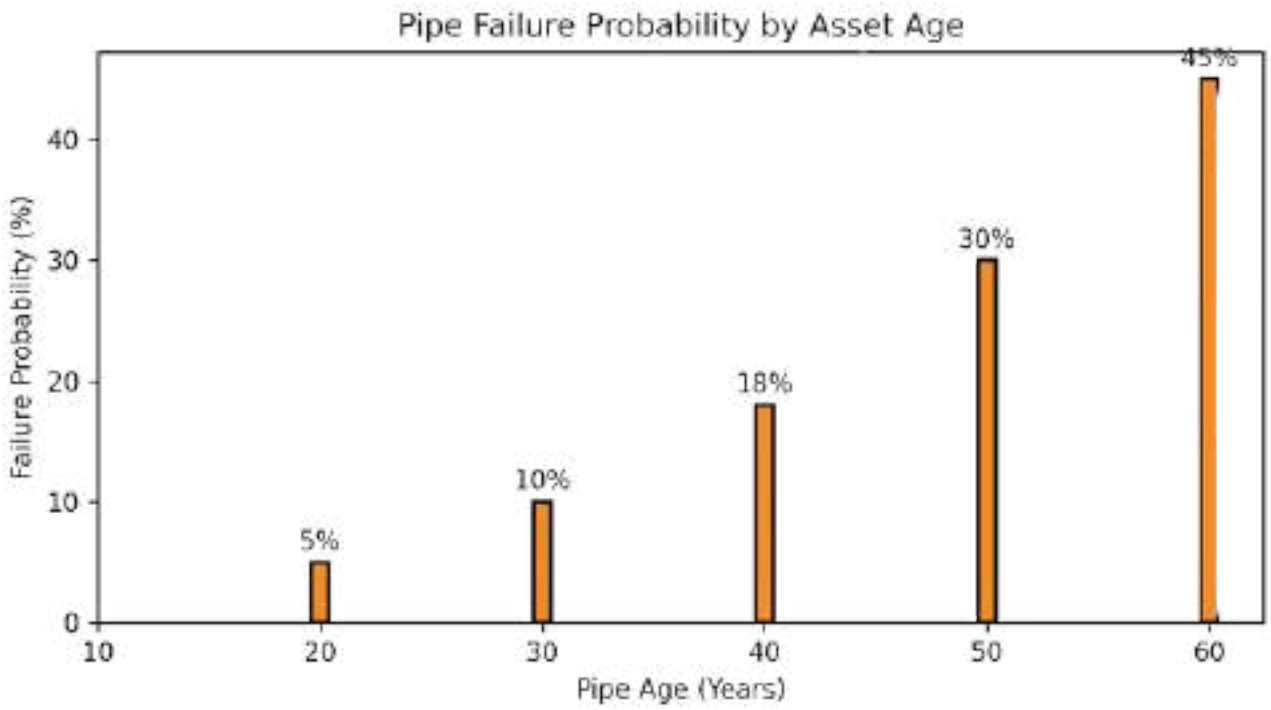
Objectives

- Develop a structured methodology for pipe renewal prioritisation.
- Quantify failure risk across the network.
- Assess lifecycle costs associated with different intervention strategies.
- Evaluate operational performance impacts.
- Optimise capital expenditure allocation.
- Improve long-term network reliability.

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Pipe Failure Risk Analysis

Failure probability increases significantly as assets approach end-of-life conditions



Key Risk Drivers

- Pipe material degradation
- Corrosion and soil conditions
- Pressure transients
- Historical break frequency
- Traffic and construction impacts
- Water quality impacts

Data Sources

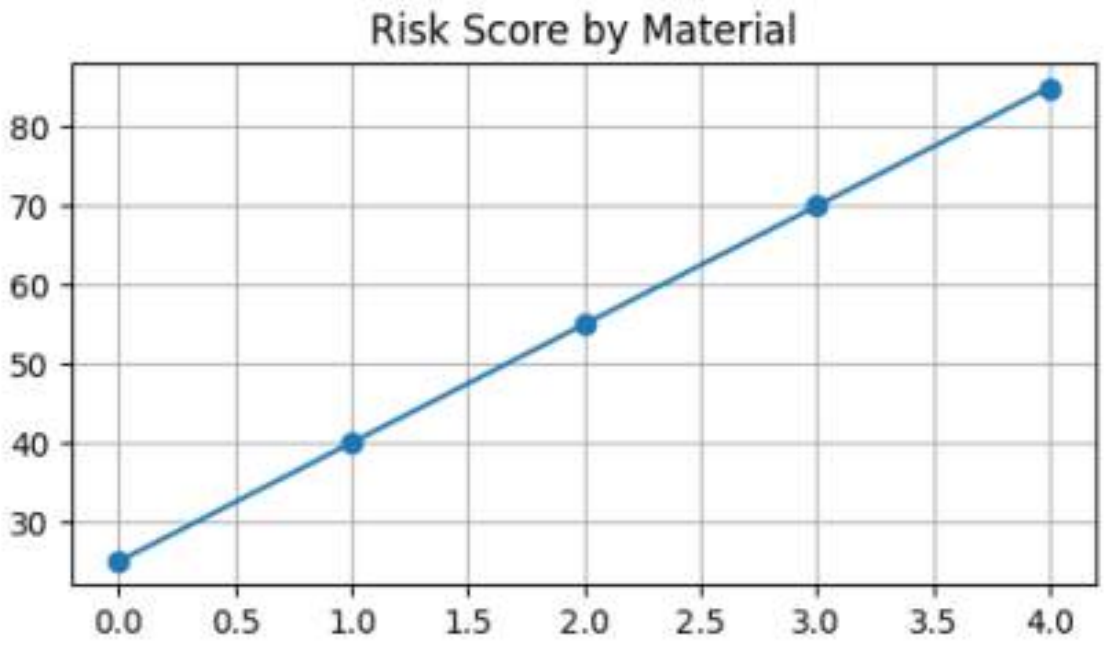
GIS records, SCADA systems, work orders, leak history, pressure monitoring, customer complaints, hydraulic models, and inspection results provide the foundation for evidence-based renewal planning.

> High-risk assets typically account for a disproportionate percentage of network failures and operational expenditure.

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Risk Assessment Framework

Risk combines Probability of Failure (PoF) and Consequence of Failure (CoF). Variables include age, material, soil conditions, pressure transients, break history, and critical customers. This section examines key factors influencing pipe renewal decisions. Asset managers evaluate historical failures, hydraulic performance, operational constraints, maintenance costs, regulatory compliance requirements, customer service levels, and long-term sustainability. Advanced analytics can integrate GIS, SCADA, work orders, inspection data, hydraulic models, and predictive failure algorithms to support investment prioritisation.

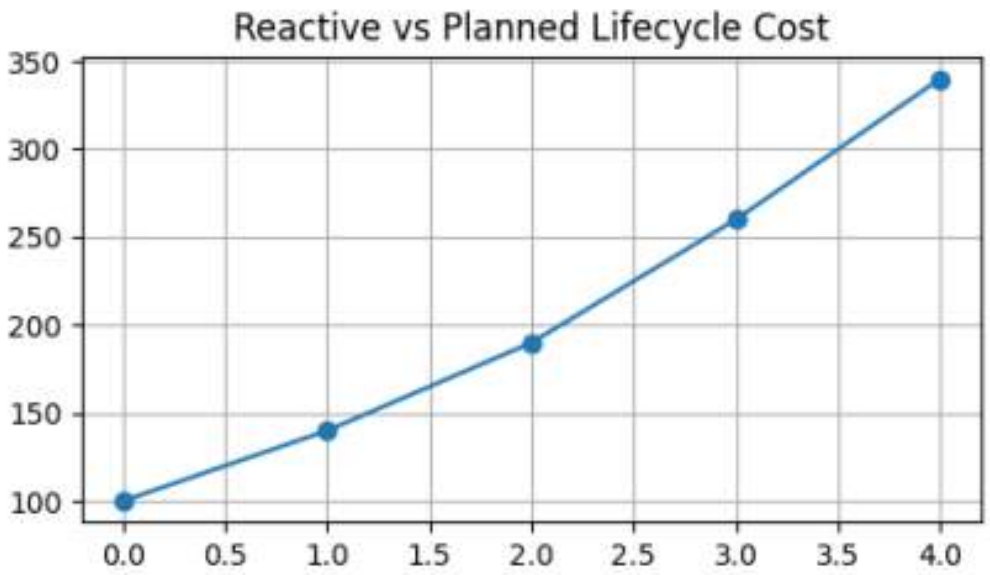


Metric	Description
Probability of Failure	Likelihood of asset failure
Consequence of Failure	Impact on customers and operations
Lifecycle Cost	Total ownership cost
Performance Score	Service and reliability impact

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Asset Criticality Analysis

Criticality ranking identifies pipes whose failure would create significant operational, financial, environmental, or social impacts. This section examines key factors influencing pipe renewal decisions. Asset managers evaluate historical failures, hydraulic performance, operational constraints, maintenance costs, regulatory compliance requirements, customer service levels, and long-term sustainability. Advanced analytics can integrate GIS, SCADA, work orders, inspection data, hydraulic models, and predictive failure algorithms to support investment prioritisation.

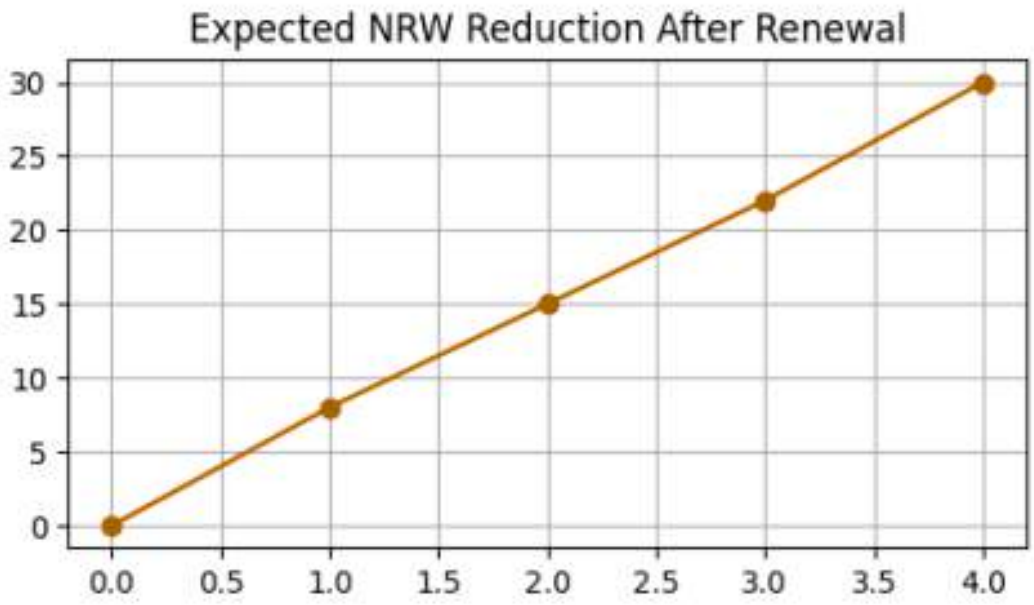


Metric	Description
Probability of Failure	Likelihood of asset failure
Consequence of Failure	Impact on customers and operations
Lifecycle Cost	Total ownership cost
Performance Score	Service and reliability impact

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Lifecycle Cost Modelling

Lifecycle cost analysis compares reactive maintenance with planned renewal and rehabilitation strategies. This section examines key factors influencing pipe renewal decisions. Asset managers evaluate historical failures, hydraulic performance, operational constraints, maintenance costs, regulatory compliance requirements, customer service levels, and long-term sustainability. Advanced analytics can integrate GIS, SCADA, work orders, inspection data, hydraulic models, and predictive failure algorithms to support investment prioritisation.

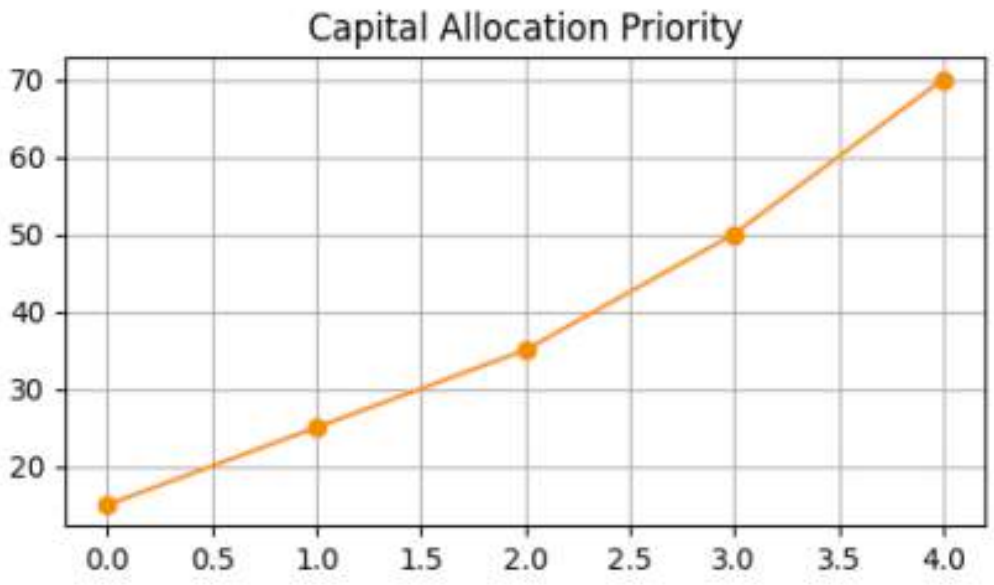


Metric	Description
Probability of Failure	Likelihood of asset failure
Consequence of Failure	Impact on customers and operations
Lifecycle Cost	Total ownership cost
Performance Score	Service and reliability impact

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Performance-Based Decision Making

Performance indicators include reliability, service continuity, leakage reduction, repair frequency, and customer impact. This section examines key factors influencing pipe renewal decisions. Asset managers evaluate historical failures, hydraulic performance, operational constraints, maintenance costs, regulatory compliance requirements, customer service levels, and long-term sustainability. Advanced analytics can integrate GIS, SCADA, work orders, inspection data, hydraulic models, and predictive failure algorithms to support investment prioritisation



Metric	Description
Probability of Failure	Likelihood of asset failure
Consequence of Failure	Impact on customers and operations
Lifecycle Cost	Total ownership cost
Performance Score	Service and reliability impact

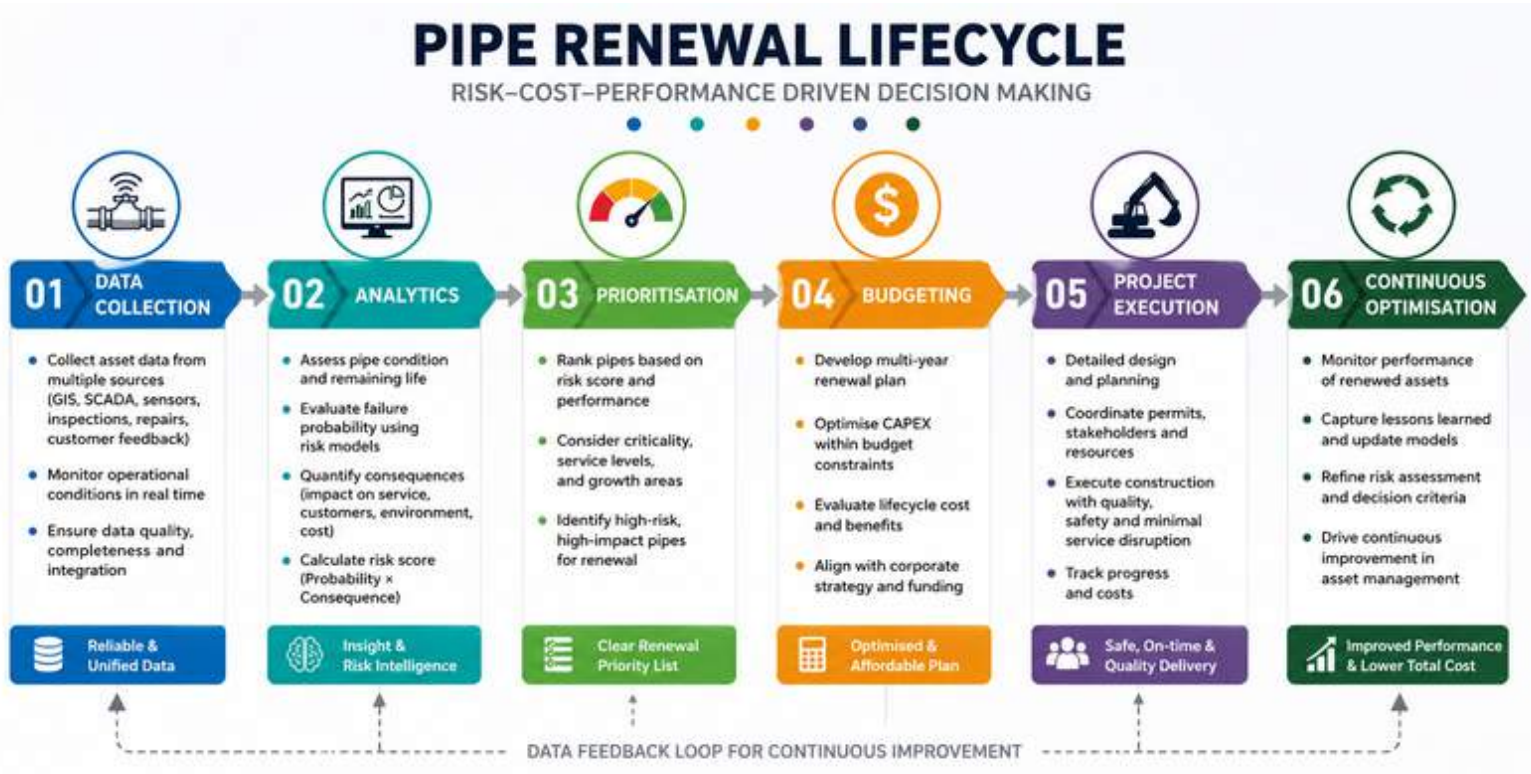
Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Renewal Prioritisation Methodology

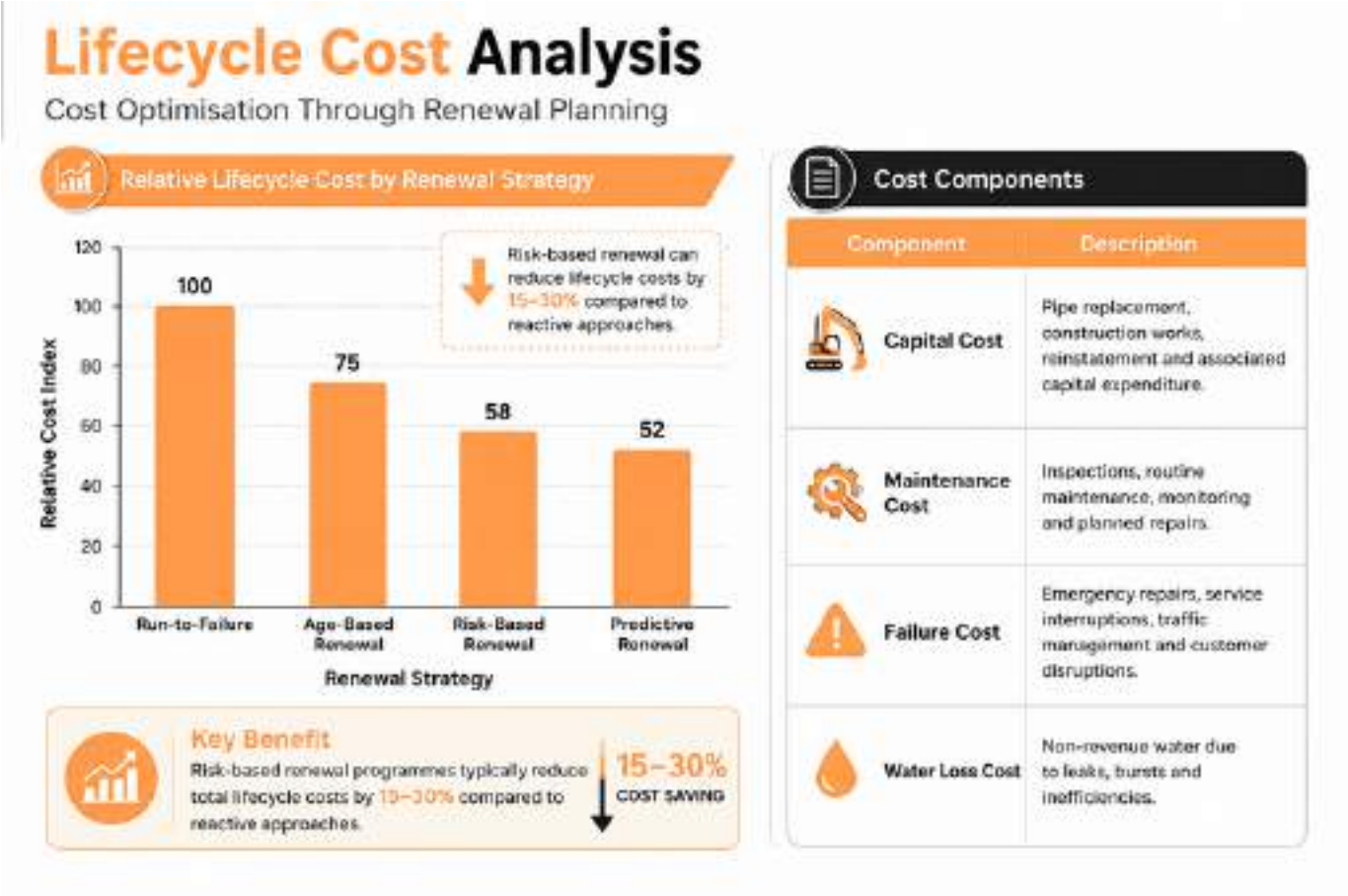
Assets are prioritised using risk, cost, and performance scoring integrated into a multi-criteria decision framework. This section examines key factors influencing pipe renewal decisions. Asset managers evaluate historical failures, hydraulic performance, operational constraints, maintenance costs, regulatory compliance requirements, customer service levels, and long-term sustainability. Advanced analytics can integrate GIS, SCADA, work orders, inspection data, hydraulic models, and predictive failure algorithms to support investment prioritisation.

Metric	Description
Probability of Failure	Likelihood of asset failure
Consequence of Failure	Impact on customers and operations
Lifecycle Cost	Total ownership cost
Performance Score	Service and reliability impact

Implementation Roadmap



Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis



Cost Optimisation Through Renewal Planning

Lifecycle cost analysis evaluates the total economic impact of asset management strategies over the entire service life of a pipeline. Rather than focusing solely on replacement costs, utilities must consider maintenance expenditure, emergency repairs, customer impacts, and water losses.

Water Reticulation Pipe Renewal Using Risk-Cost-Performance Analysis

Conclusion

Risk-Cost-Performance Analysis enables utilities to move beyond age-based replacement strategies and prioritise investments where they generate the highest operational and financial value. By integrating risk modelling, lifecycle costing, and performance metrics, utilities can improve reliability, reduce failures, and optimise long-term infrastructure spending.

For more information :

+65 6760 6647

www.tigernix.com

21 Woodlands Cl, #05-47 Primz Bizhub, Singapore 737854